[Title of Document] SPECIFICATION

[Title of the Invention] SHOCK-ABSORBING STRUCTURE OF BATTERY COVER

[Scope of Claim for a Patent]

[Claim 1] A shock-absorbing structure of a battery cover including a plurality of shock-absorbing ribs formed on an outer surface of the cover which protects a battery.

[Claim 2] A shock-absorbing structure according to claim 1, in which said plurality of ribs are arranged parallel to each other.

[Claim 3] A shock-absorbing structure according to claim 1, in which said plurality of ribs are crossed in a lattice-like manner.

[Claim 4] A shock-absorbing structure of a battery cover including projections which are formed on an inner surface of the cover, protecting a battery, and can abut respectively against fixing members engaged respectively with electrodes of said battery.

[Claim 5] A shock-absorbing structure according to claim 4, in which each of said projections is formed in an annular shape, and distal end portions of said electrodes are received in said projections, respectively.

[Claim 6] A shock-absorbing structure according to claim 4 or claim 5, in which a gap between said projection and said fixing member is smaller than a gap between said electrode and said

cover.

[Claim 7] A shock-absorbing structure of a battery cover including a plurality of ribs as defined in any one of claims 1 to 3, and projections and fixing members as defined in any one of claims 4 to 6.

[Claim 8] A shock-absorbing structure according to claim 7, in which said plurality of ribs and said projections are disposed generally symmetrically with respect to a plane of said cover.

[Claim 9] A shock-absorbing structure according to any one of claims 1, 2, 7 and 8, in which said plurality of ribs are interconnected by bulge portions formed on said cover.

[Claim 10] A shock-absorbing structure according to claim 9, in which said bulge portions and said ribs project generally to the same height.

[Detailed Description of the Invention]
[0001]

[Technical Field to which the Invention belongs]

The present invention relates to a shock-absorbing structure of a battery cover designed to protect battery electrodes and so on in a battery connecting plate (which serially connects together batteries of an electric car etc.) at the time of a vehicle collision.

[0002]

[Prior Art]

In a conventional power source for an electric car and a hybrid car (powered by electricity and gasoline), a plurality of batteries are serially connected together to provide a battery block (battery assembly), and then opposite ends of this battery block are covered with covers or the like, and this power source device is mounted within a vehicle body.

[0003]

Fig. 12 shows one form of conventional battery connecting plate for connecting a plurality of batteries together.

The battery connecting plates 70 and 71 are attached to opposite ends of a battery block 72, respectively, and each of these battery connecting plates has a plurality of juxtaposed bus bars 75 (made of electrically-conductive metal) mounted on an elongate casing (plate body) 74 made of a synthetic resin.

[0004]

Each of the bus bars 75 has two insertion holes 78 for respectively passing externally-threaded-type positive and negative electrodes 76 and 77 of the corresponding adjacent batteries 73 therethrough, and these bus bars 75 are fixedly secured to the casing 74 by press-fitting, insert-molding or other means. Each of the electrodes 76 and 77 is connected and fastened to the bus bar 75 by a nut 79.

[0005]

Bus bars 83, each having one insertion hole 82, are fixedly

secured respectively to opposite ends of the front battery connecting plate 70. The positive electrode 76 of the battery 73, disposed at one end portion of the battery block 72, and the negative electrode 77 of the battery 73, disposed at the other end of the battery block 72, are connected respectively to power wires (not shown), each having a terminal, through the respective bus bars 83.

[0006]

A cover 80 is pivotably mounted on the casing 74, and when the cover 80 is closed, the bus bars 75 and 83, the electrodes 76 and 77 and the nuts 79 within receiving portions 81 are protected by this cover.

[0007]

In the above structure, the cover 80 is formed integrally with the casing 74 through hinges. However, as shown in Fig. 13, there is also the case where there are provided a cover 61 and a casing 62 which are separate from each other, and are made of a synthetic resin. In either case, the cover 61, 80 is fixed to the casing 62, 74 by retaining means or the like.

[0008]

In Fig. 13, reference numeral 10 denotes an externally-threaded-type electrode of a battery (not shown), and reference numeral 11 denotes a nut for connecting the electrode 10 to a bus bar or the like.

[0009]

[Problems that the Invention is to solve]

In the above conventional structure, when a large external force b was applied to the cover 61, for example, at the time of a vehicle collision, the cover 61 was broken, and besides an impact was transmitted to the electrodes 10 and bus bars within the casing 62, so that for example as shown in Fig. 14 the distal ends of the electrodes 10 broke through the cover 61 to project to the exterior. This resulted in possibilities that the batteries were short-circuited, which was dangerous, and that the batteries were adversely affected.

[0010]

In the case of increasing the strength of the cover 61 by increasing the wall thickness of this cover in order to deal with the above problems, the weight of the cover 61 increased, and the resin moldability thereof was affected, and the cost increased. And besides, there was a fear that abnormal sounds were produced because of the increased inertia force of the cover 61 due to vibrations of the vehicle. Furthermore, a large cost was needed for developing a special material of shock-relieving properties, which resulted in a problem that the cost of the cover 61 itself increased.

[0011]

With the above problems in view, it is an object of the present invention to provide a shock-absorbing structure of a battery cover which can easily and positively absorb and relieve an external impact at low costs, and prevents the projecting of battery electrodes from the cover, and will not adversely

affect the parts inside the cover.

[0012]

[Means for solving the problems]

According to a first aspect of the present invention, there is provided a shock-absorbing structure of a battery cover including a plurality of shock-absorbing ribs formed on an outer surface of the cover which protects a battery.

Preferably, the plurality of ribs are arranged parallel to each other.

Preferably, the plurality of ribs are crossed in a lattice-like manner.

According to a second aspect of the present invention, there is provided a shock-absorbing structure of a battery cover including projections which are formed on an inner surface of the cover, protecting a battery, and can abut respectively against fixing members engaged respectively with electrodes of the battery.

Preferably, each of the projections is formed in an annular shape, and distal end portions of the electrodes are received in the projections, respectively.

Preferably, a gap between the projection and the fixing member is smaller than a gap between the electrode and the cover.

According to a third aspect of the present invention, there is provided a shock-absorbing structure of a battery cover including a plurality of ribs as defined in any one of claims 1 to 3, and projections and fixing members as defined in any one of claims 4 to 6.

Preferably, the plurality of ribs and the projections are disposed generally symmetrically with respect to a plane of the cover.

Preferably, the plurality of ribs are interconnected by bulge portions formed on the cover.

Preferably, the bulge portions and the ribs project generally to the same height.

[0013]

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the present invention will now be described in detail with reference to the drawings.

Figs. 1 to 3 broadly show shock-absorbing structures of a battery cover forming the first embodiment of the present invention.

[0014]

In the structure shown in Fig. 1, a plurality of juxtaposed parallel shock-absorbing ribs 2 are formed on the surface (outer surface) of the battery cover (hereinafter referred to as "cover") 1 made of a synthetic resin. The number of the ribs 2 may be two or may be large.

[0015]

When an external impact is applied to the cover 1, the ribs 2 are crushed to absorb and relieve the impact as shown in Fig. 2. Therefore, the impact is prevented from acting on externally-threaded-type electrodes (not shown) of batteries, nuts, bus bars and so on disposed inside the cover 1, that is,

provided at a casing, and these parts are safely protected by the cover 1. Since the electrodes are prevented from projecting from the cover, the short-circuiting will not occur. The ribs 2 achieve the shock-absorbing effect equal to or higher than that attained by increasing the wall thickness of the cover 1. At least two ribs 2 should be provided, but when the cover 1 need to be protected over a wider area thereof, it is necessary to provide more than two ribs 2.

[0016]

In the case where an impact acts on the cover 1 in every direction, that is, directions indicated by broken lines a to c in Fig. 1, it is more effective to arrange shock-absorbing ribs 4 and 5 in a lattice-like or mesh-like fashion on a cover 1, as shown in Fig. 3. The transverse ribs 4 and the longitudinal ribs 5 perpendicularly intersect each other to form shock-absorbing portions.

[0017]

The angle of intersection of the ribs 4 and 5 is not limited to a right angle. The number of the ribs 4, as well as the number of the ribs 5, may be two, or a large number of ribs 4 and 5 may be arranged transversely and longitudinally. In the example of Fig. 3, the ribs 4 and 5 are positively crushed upon application of an impact in every direction, thereby absorbing the impact. In any case, it is necessary that the ribs 2, 4 and 5 should be crushed in a compressing direction.

[0018]

Spaces 6, each formed between the ribs 2 (in the example of Fig. 1), and spaces 7, each formed between the crossed ribs 4 and 5, are similar to holes formed in a resin material in a molding operation, and the resin moldability of the cover 1, 3 is very good. Namely, molding sink and warp will not occur during the molding, and also the molding time is reduced. The weight of the cover 1, 3 is reduced because of the formation of the spaces 6, 7 between the ribs.

[0019]

The ribs 2, 4 and 5 are formed so as to be disposed at positions corresponding to the externally-threaded-type electrodes of the batteries. Alternatively, these ribs can be formed at other portions of the cover. The cover 1, 3 is fixed to the casing (not shown) by retaining means or the like.

[0020]

Figs. 4 to 7 broadly show a shock-absorbing structure of a battery cover forming a second embodiment of the present invention.

[0021]

In Fig. 4, reference numeral 8 denotes an insulative cover made of a synthetic resin, reference numeral 9 a casing made of a synthetic resin, reference numeral 10 an externally-threaded-type electrode of a battery (not shown), and reference numeral 11 a nut (fixing member) which fastens and connects a bus bar (not shown) and a wire with a terminal.

[0022]

The cover 8 includes a top wall 13 and four side walls 16 while the casing 9 includes a bottom wall 12 and four side walls 17. The electrodes 10 extend respectively through round holes, formed through the bottom wall 12 of the casing 9, into the interior of this casing 9.

[0023]

Annular projections (or circular ribs) 14, are formed integrally on a reverse side (inner surface) of the top wall 13 of the cover 8, and are opposed respectively to the nuts 11, as shown in Fig. 5. A distal end 14a of each projection 14 is in close proximity to the corresponding nut 11, with a narrow gap S_1 formed therebetween. A distal end portion of each electrode 10 is inserted in an internal space 15 of the corresponding projection 14, and a relatively-large gap S_2 is formed between the distal end 10a of the electrode 10 and the reverse side of the cover 8. The gap S_1 at the distal end of the projection is smaller than the gap S_2 at the distal end of the electrode.

[0024]

The distal end 14a of the projection 14 can be come into contact with a distal end surface 11a of the nut 11 over the entire circumference thereof as indicated in phantom d in Fig. 6. Namely, in a condition shown in Fig. 5, when an impact is applied to the outer surface of the cover 8, the distal end 14a of the annular projection 14 first abuts against the distal end surface 11a of the nut 11, so that the projection 14 is compressed or crushed in the longitudinal direction as shown in Fig. 7,

or is spread or deformed outwardly, thereby efficiently absorbing and relieving the impact b. Then, the distal end 10a of the electrode 10 abuts against the reverse side of the cover 8 to push the cover 8 in a direction opposite to the impact-applying direction, thereby deforming the cover in a slightly-projecting manner. In this condition, the impact b is completely absorbed, so that the electrode 10 will not break through the cover 8.

[0025]

Therefore, the breakage of the cover 8 is prevented, and the electrode 10 does not project to the exterior, and therefore the breakage of the electrode 10 and the short-circuiting of the high-voltage batteries are prevented, and the nuts 11, the bus bars, the terminals, each having a power wire, and so on are prevented from deformation and breakage. If the impact is weak, only the projection 14 is buckled and deformed, and the cover 8 will not be deformed. Since the projection 14 has an annular shape, the impact is positively absorbed uniformly.

[0026]

Since the distal end portion of the electrode 10 (projecting from the nut 11) is received in the internal space 15 of the insulative projection 14, the short-circuiting is less liable to occur even when a potential difference develops between the electrode 10 and the exterior of the cover 8. The cover 8 only has the annular projections 14 formed integrally therewith, and therefore the moldability of the cover is good, and molding sink and warp will not occur. And besides, as compared with the case

where the wall thickness of the cover 8 is increased, the molding time is reduced, and the weight of the cover is reduced, and the cost thereof is reduced.

[0027]

Instead of the nuts 11 serving as the fixing members, retaining rings (not shown) or other suitable members can be used. A slit can be formed in the annular (tubular) projection to adjust the shock-absorbing force. Each of the annular projections can be replaced by a plurality of bar-like projections arranged in an annular fashion around the electrode 10.

[0028]

Fig. 8 broadly shows a third embodiment having the features of the first and second embodiments.

[0029]

A pair of shock-absorbing ribs 19 are formed on an outer surface of a cover 18 made of a synthetic resin, and annular projections 20 are formed on a reverse side of the cover 18, and the row of annular projections 20 and the ribs 19 are disposed generally symmetrically with respect to the plane of the cover 18.

[0030]

That portion of the cover 18, lying between the pair of ribs 19, is slightly reduced in thickness, and bulge portions 21 of a curved shape are formed at this portion of the cover 18. The inner diameter of each projection 20 is equal to the inner diameter of the bulge portion 21, and the inner peripheral

surface of the projection 20 is continuous with the inner surface of the bulge portion 21. The depth of a bore (internal space) 22 of the projection 20 is larger than the distance between the distal end surface 11a of the nut 11 and the distal end 10a of the electrode 10, and therefore when an impact is applied, a distal end 20a of the projection 20 first abuts against the distal end surface 11a of the nut 11.

[0031]

An impact is first applied to a vehicle body (iron sheet) 23, and then the iron sheet 23 abuts against the pair of ribs 19, and at the same time the projection 20 abuts against the nut 11. The ribs 19 and the projection 20 are crushed, and the impact is positively absorbed efficiently by the synergetic effect of the ribs 19 and the projection 20.

[0032]

As a result, the interior of the cover 18 is positively protected. One pair of ribs 19 or more absorb the impact, and also dissipate the impact. The projection 20 is crushed or spread and deformed to absorb the impact, thereby particularly protecting the distal end portion of the electrode 10.

[0033]

The ribs 19 and the projections 20 are formed on the opposite sides (outer and inner surfaces) of the cover 18, and are disposed generally at the same portions of the cover (facing away from each other), and project away from each other. Therefore, the resin-molded cover can be easily removed from a mold, and the

mold can be simplified in construction, and the cost of the cover 18 is reduced.

[0034]

Instead of the pair of ribs, more than two parallel ribs or lattice-like ribs can be provided.

[0035]

Figs. 9 to 11 show a more detailed form of the third embodiment.

A cover 25, shown in Fig. 9, is made of a synthetic resin, and includes a flat plate-like, wide wall portion 26, a narrow wall portion 28, which is connected to an upper edge of the wall portion 26 through a slanting portion 27, and is recessed a step with respect to the wall portion 26, and an edge portion 29 extending perpendicularly from the wall portion 28. A bulge wall 30 of a rectangular cross-section is formed integrally on the narrow wall 28 (which is recessed a step as described above), and at least a pair of shock-absorbing ribs 31 are formed on an outer surface of the bulge wall 30 to provide an electrode-corresponding portion 32.

[0036]

The pair of elongate ribs 31 are formed on the cover 25 over the entire length thereof, and the pair of ribs 31 are interconnected by bulge portions 33 of a generally semi-spherical shape which are provided respectively for externally-threaded-type electrodes of batteries (not shown). The bulge portions 33 are arranged at equal intervals, and increase the bending strength and buckling strength of the ribs 31 so

that the ribs 31 can be positively crushed in the direction of the height of the ribs 31 upon application of an external force (impact) in every direction. Also, the bulge portions 33 can be crushed together with the ribs 31 to absorb the impact more effectively.

[0037]

Preferably, an annular projection (20) as shown in Fig. 8 is formed at the reverse side of each bulge portion 33 (that is, the reverse side of the wall portion 28), this annular projection being slightly larger in inner diameter than the bulge portion 33. The height of projecting of the projection (20) can be reduced by an amount corresponding to an amount of insertion of the distal end of the electrode (10) into an internal space of the bulge portion 33. The short projection (20) is crushed in a compressing direction to absorb an impact rather than spreads outwardly.

[0038]

The distal end of the electrode of each battery (not shown) is disposed within the corresponding projection (20), and elongate distal end surfaces of the batteries (from which the electrodes project, respectively) are disposed close to the narrow wall portion 28, and extend vertically in Fig. 8. The electrodes are provided at upper portions of the batteries, respectively.

[0039]

The cover 25 has frame-like retaining portions 34, and the cover 25 is retained relative to a casing (not shown), having bus bars, by these retaining portions 34 engaged respectively

with engagement projections formed on the casing. Openable/closable portions 36 are formed integrally with opposite (right and left) ends of the cover 25 through respective hinges 35, and the right and left batteries of the battery block (which are connected respectively to terminals each having a power wire) are disposed in opposed relation to these portions 36, respectively.

[0040]

A cover 38, shown in Fig. 10, includes a flat plate-like wall portion 39, a narrow wall portion 41 connected to an upper edge of the wall portion 39 through a thin hinge 40, and an edge portion 42 extending perpendicularly from the wall portion 41. At least a pair of ribs 43 and bulge portions 44 of a generally semi-spherical shape are formed on an outer surface of the narrow wall portion 41 to provide an electrode-corresponding portion 45. The two wall portions 39 and 41 are disposed generally in a common plane, and the electrode-corresponding portion 45 can be opened and closed through the hinge 40. In a closed condition of the electrode-corresponding portion 45, the edge portion 42 is retained relative to a casing (not shown) by retaining means 46, and the electrodes and so on are received within and protected by the cover 38. Preferably, a shock-absorbing projection (designated by reference numeral 20 in Fig. 8) is formed at the reverse side of each bulge portion 44.

[0041]

At the time of a vehicle collision, the pair of ribs 43

and the bulge portions 44 are crushed to absorb an impact. Even when the bulge portion 44 is crushed, a hole will not be formed through the bulge portion 44. The height of the bulge portions 44 is generally equal to the height of the ribs 43. In the case where the projections (20) are provided, the impact can be further absorbed by the crushing of the projections (20).

[0042]

A cover 50, shown in Fig. 11, is used for two batteries connected together. This cover 50 includes at least a pair of short shock-absorbing ribs 52, formed on an upper portion (Fig. 11) of a flat plate-like top wall 51, and a pair of bulge portions 53 of a generally semi-spherical shape which are formed on the upper portion (Fig. 11) of the top wall 51, and interconnect the two ribs 52. Preferably, as described above, an annular projection (designated by reference numeral 20 in Fig. 8) is formed at the reverse side of each bulge portion 54.

[0043]

The cover 50 in its closed condition is attached to a casing 56, and power wire-leading holes 55 are formed through a side wall 54 of the casing 56. Electrode-connecting bus bars and/or terminals each with a power wire are received within the casing. Instead of the pair of ribs 52 and the bulge portions 53, a plurality of crossed or lattice-like ribs can be provided as shown in Fig. 3. The shock-absorbing structures of Figs. 9 to 11 are basically identical in construction and effects.

[0044]